FIBER CEMENT BUILDING MATERIALS WITH LOW DENSITY ADDITIVES

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 12/802,346 filed Jun. 7, 2010, which is a continuation of U.S. patent application Ser. No. 12/039,372 filed Feb. 28, 2008 (U.S. Pat. No. 7,727,329) which is a continuation of U.S. patent application Ser. No. 10/414,505 filed Apr. 15, 2003 (U.S. Pat. No. 7,658,794) which is a continuation of U.S. patent application Ser. No. 09/803,456, filed Mar. 9, 2001 (U.S. Pat. No. 6,572,697), which claims priority to and the benefit of U.S. Provisional Application No. 60/189,235, filed Mar. 14, 2000, the entire content of all applications is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to building materials and methods for making the same, and more particularly to the addition of low density additives (LDA) into cementitious cellulose fiber-reinforced building materials.

2. Description of the Related Art

Fiber-reinforced cement (FRC) products such as water-resistant building sheets have been used for building since 1895. In recent history reinforcing fibers used in such products have included not only asbestos fibers, but also cellulose fibers (see Australian Patent No. 515151), metal fibers, glass fibers and other natural and synthetic fibers. Typically, the density of such building sheets is from about 1.2-1.7 g/cm^3, the variation in density typically being achievable by compression and dewatering of the fiber cement slurries used in manufacture and by varying the amount of fiber used. At these densities, the cement based matrix has few voids, which results in lower water absorption which has usually been considered necessary for good durability performance of cement matrices.

The densities of fiber cement described above mean the products are heavier than timber based products of equal dimension and have reduced workability. Workability encompasses the ease with which a board is handled and installed. Therefore, fiber cement building products are more difficult to cut, machine and nail than timber and timber based products. In this regard, the density of natural timber sheets typically ranges from about 0.7-0.9 g/cm^3 for dry hardwoods and from about 0.38-0.6 g/cm^3 for dry softwoods. Thus, a density-modified fiber cement material with density similar to timber may be expected to improve workability and enable lighter, more nailable, easier to cut and easier to machine products to be manufactured. However, this would have to be achieved while retaining the durability, fire resistant, rot proof and water resistant properties of fiber cement if the density modified fiber cement is to be used in the same range of applications.

Prior art describes how lightweight inorganic powders can be added as density modifiers in cement or fiber-reinforced cement materials. Low density additives for FRC products are defined as having a loose bulk density of about 0.8 g/cm^3 (about 50 lbs./cu.ft.) or less. The typical low density additives (LDA) used include low bulk density calcium silicate hydrates (CSH), expanded polystyrene beads (EPS), expanded vermiculite, expanded perlite, expanded shale, and expanded clay. The density modification of cement-based materials with such inorganic particles is primarily achieved by introducing porosity into the material. Typically, the pore spaces are filled with water when the material is submerged in water or exposed to rain for a length of time. This causes these materials to have poorer wet to dry dimensional stability (moisture resistance), a higher saturated mass, and poor freeze-thaw resistance.

Accordingly, there is a need for a lightweight FRC building material and method for manufacturing the same with improved wet to dry dimensional stability over that of typical density modified products. Secondly, the lightweight building material should maintain similar wet to dry dimensional stability as that of FRC products without density modifiers if the density modified material is to be used in the same range of applications. In addition, it is highly preferred in some applications that the material also have a low saturated mass, good freeze-thaw resistance, and high temperature dimensional stability. Finally, it is also desirable to have a FRC building product where lower ranges of densities closer to that of timber and timber based products can be achieved with improved durability.

SUMMARY OF THE INVENTION

Two low density additives have been evaluated that have properties more desirable to FRC building materials than typical low density additives. These two low density additives are volcanic ash and hollow ceramic microspheres. One embodiment of the invention includes the addition of volcanic ash (VA) into an FRC building material. A second embodiment comprises the addition of hollow ceramic microspheres (microspheres) into the FRC building material. A third embodiment incorporates the blending of microspheres with volcanic ash and/or other typical low density additives into the FRC building material. The third embodiment with the blend of microspheres and VA and/or other low density additives may be more preferable than the first embodiment with the introduction of volcanic ash by itself. The second embodiment with the addition of microspheres by themselves may be more preferable than either the first or third embodiments as described above, depending on the properties being considered for a particular application.

Compared to current FRC products, one advantage of the first embodiment with volcanic ash is that it provides the product with low densities and improved workability at an economical price, as well as improved dimensional stability over that of typical low density additives.

The second embodiment encompasses the addition of microspheres in fiber-cement products. Compared to current FRC products, the benefits of adding microspheres include the low density and improved workability of the product without increased moisture expansion or freeze-thaw degradation associated with the addition of lightweight inorganic materials to FRC mixes. Moreover, the addition of microspheres provides improved thermal dimensional stability for FRC material.

The third embodiment relates to the addition of microspheres in combination with VA and/or other typical low density additives in FRC material. Blending microspheres with other low density additives is advantageous because lower density FRC products can be achieved with less weight percent addition (as compared to microspheres only) due to the lower densities of VA and other typical LDA relative to microspheres. This also enables fiber cement products to achieve lower density ranges to further improve workability, while microspheres minimize the adverse effects typical low density additives have on wet-to-dry dimensional stability and overall durability.